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Energy efficiency and carbon trading potential in Malaysia

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ABSTRACT

The damage inflicted by global warming is happening far faster than any experts have predicted or anticipated. Since the Kyoto Protocol was signed in 1997 to fight global warming through reducing global greenhouse gases (GHGs) emission, the world climate pattern has worsened at an accelerated rate beyond expectation. While developed countries sanctioned by the protocol are committed to achieve their GHG emission targets, developing nations play similar roles on a voluntary basis. Since almost all of the GHGs emissions come from energy sector, it is obvious that energy policy and related regulatory frameworks play imperative roles in realizing the Kyoto Protocol objectives. With carbon dioxide (CO_2) touted as the main remedy in the GHGs emissions, it is only reasonable that carbon trading becomes the essential element in the Protocol. Recently a milestone is marked in the Kyoto Protocol with the 2009 Climate Summit in Copenhagen, Denmark, with all participating countries further committed themselves in fulfilling the protocol's obligations before the commitment period due in 2012. It is worthwhile to review the various energy efficiency efforts and carbon trading potential in Malaysia, a country which although does not bear any obligation, has ratified and lauded the cause of the protocol. Malaysia as a developing nation is seen as a direct beneficiary from carbon trading and in this paper, how the country energy policies have evolved over the years with concerted efforts from the government to minimize its carbon footprint through numerous energy efficiency implementations are discussed in length. The impact from the 2009 Climate Summit on Malaysia is also briefed.

Contents

1. Introduction

In the near future, the energy consumption is expected to proliferate especially in developing countries. This was led by significant increases in industrial activity in recent times which consequently results in a massive increase of pollutants being released to the atmosphere, water and soil, altering their composition, and causing harmful effects on the environment and human health. Although environmental problems are not an issue of interest to the world until the last century, some historical events had shown that the concerns on the effect of certain man-made pollutants on human health have begun some centuries ago [1]. Air pollutants mainly come from discharges of gases from industry, motor vehicles and domestic wood burning [2]. The most widespread pollutant which is called primary pollutant is none other than the major greenhouse gas (GHG), carbon dioxide (CO_2).

Due to the harmful impact of air pollutants, regulatory agencies have enacted strict regulations to limit their emission, with the

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important international accord, Kyoto Protocol inked in 1997 to battle global warming and more than a decade later, climate change has worsened and accelerated beyond some of the grimmest of warnings made back then. As the world has talked for years what is the next step to take, new ship passages are opened through the ice frozen summer sea ice of the Arctic. In Greenland and the Antartica, ice sheets have lost trillions of tonnes of ice. Mountain glaciers in Europe, South America, Asia and Africa are shrinking faster than ever before. And in the dozen years leading to the 2009 Climate Summit in Copenhagen recently, the world's oceans have risen by about 3.7 cm and experts estimate the sea level to rise by 100 cm by year 2100 [3]. Temperatures over the past 12 years are 0.4 °C warmer since 1997. Consequently, in recent years, news on droughts, wildfires and deluges that wrecked havoc all over the globe can be heard more often than ever. The fact that the gloomiest climate models back in the 1990s did not even forecast results quite this bad and this fast have set off the alarms all over the world on the urgency to address the issues of global warming and climate change.

The effects of GHGs are more prevailing and happening sooner than anticipated. The planet warming by 7 °C and sea levels rising by 100 cm by 2100 are scenarios that just two years ago viewed as improbable. In the widest overview on global warming since a landmark report by the United Nation Inter-government Panel on Climate Change (IPCC) in 2007, stated that manoeuvring room for tackling the carbon crisis is now almost exhausted [4]. Since 1980, global CO_2 emission has been increasing as depicted in Fig. 1 and the atmospheric CO_2 concentration has been rising steadily year-on-year and hit a record high of 385.99 parts per million (ppm) as in November 2009 as shown in Fig. 2. Emissions of heat-trapping CO_2 from fossil fuels are tracking near the highest scenarios considered so far by the IPCC. They are nearly 40% higher in 2008 than back in 1990, with a 3-fold acceleration over the past 18 years. Even if global emission rates are stabilized at present-day levels, just 20 more years of emissions would result a 25% probability that warming exceeds 2 °C, even with zero emissions after 2030. Every year of delayed action increases the chances of exceeding 2 °C warming [7]. Generally, CO_2 emission is closely related to human activities, namely power generation, deforestation, transportation, industrial, residential and commercial activities. CO_2 is discharged into the atmosphere from combustions of fossil fuels such as oil, natural gas and coal as sources of energy. If left unchecked, the CO_2 emission can exacerbate global warming and lead to environmental destruction and health hazards which are already quite rampant nowadays. Since it is undeniable that many countries are still very much dependent on fossil fuels to sustain their growth, the energy policies implemented in these countries can directly and significantly impact the amount of CO_2 reduction achieved. As energy demand is inevitably on the rise due to rapid development and growing populations, it is only judicious to divert energy from fossil fuels to renewable and sustainable energy sources.

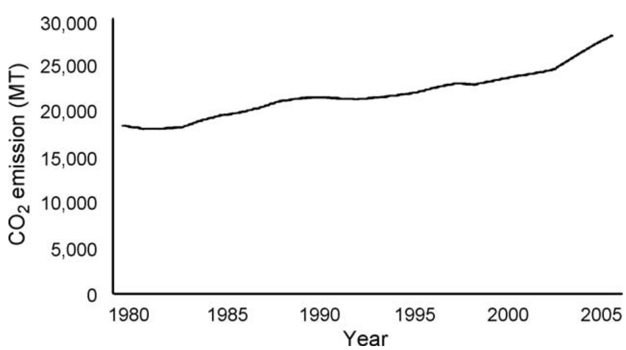


Fig. 1. Global CO_2 emissions from 1980 to 2005 [5].

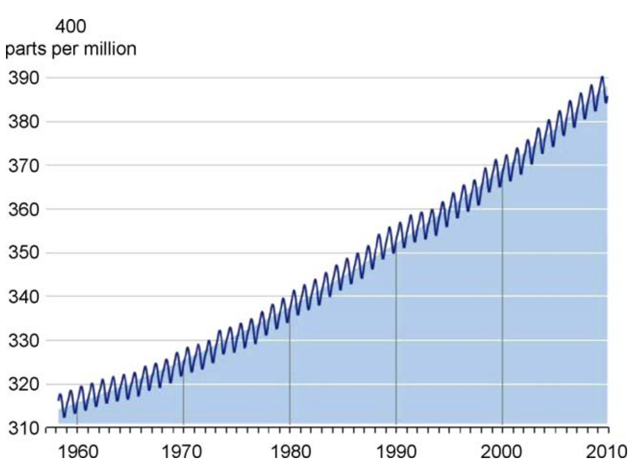


Fig. 2. Atmospheric CO_2 concentrations [6].

Even though bears no obligation in reducing GHGs emissions as a non-Annex I country, Malaysia has started to strive towards a low carbon economy and community through its various green policies and energy efficiency (EE) programmes in recent years, which is the main focus of this paper. In the following section, the energy scenario and the various policies that are adopted in Malaysia to mitigate CO_2 emission are highlighted, including the various EE initiatives that have taken place so far in the country. Subsequently, this paper also discusses the carbon trading potential and the various challenges in Malaysia, which is part of the Clean Development Mechanism (CDM) programme introduced in the Kyoto Protocol with the goal to support non-Annex I countries to achieve sustainable development and assist developed countries like Malaysia to achieve their CO_2 emission reduction obligation simultaneously.

2. Malaysia energy scenario

2.1. Energy consumption and CO_2 emission

The total energy consumption in Malaysia was estimated at about 2.5 quadrillion Btu as in 2007, which is a 400% increase from the early 1980s as indicated in Fig. 3, and this is considered relatively high among developing countries and was even higher than some developed countries [8]. The final commercial energy demand in 2007 increased by 9.8% in total to settle at 44,268 ktoe compared to 40,318 ktoe in 2006. The share in commercial energy demand was highest for the industrial sector (43.2%) and transport sector (35.5%). This was followed by the residential and commercial (14.0%), non-energy (6.7%) and agriculture sectors (0.6%). All sectors showed an upward trend compared to year 2006. The total electricity gross generation in 2007 registered 101,325 GWh, an increase of 8.7% from 2006. On the other hand, the electricity consumption was 89,298 GWh, an increase of 5.6% from 2006. In 2007, the electricity consumption from the residential sector increased by 5.5% to register 1598 ktoe (18,572 GWh) compared to 2006, while the commercial sector increased by 9.6% to reach 2496 ktoe (29,009 GWh). The electricity consumption in the industrial sector recorded an increase of 3.2% to register 3587 ktoe (41,689 GWh). The increase was influenced by higher gross domestic product (GDP) in the manufacturing sector recorded in 2007. The electricity consumption from the transport sector, however, decreased from 5421 toe (63 GWh) in 2006 to 3554 toe (41 GWh). Natural gas still provides the largest portion in the electricity generation mix with 56.6%, follows by coal and hydropower at 34.2% and 6.9%, respectively. The remaining 2.3% is contributed by oil and others [9].

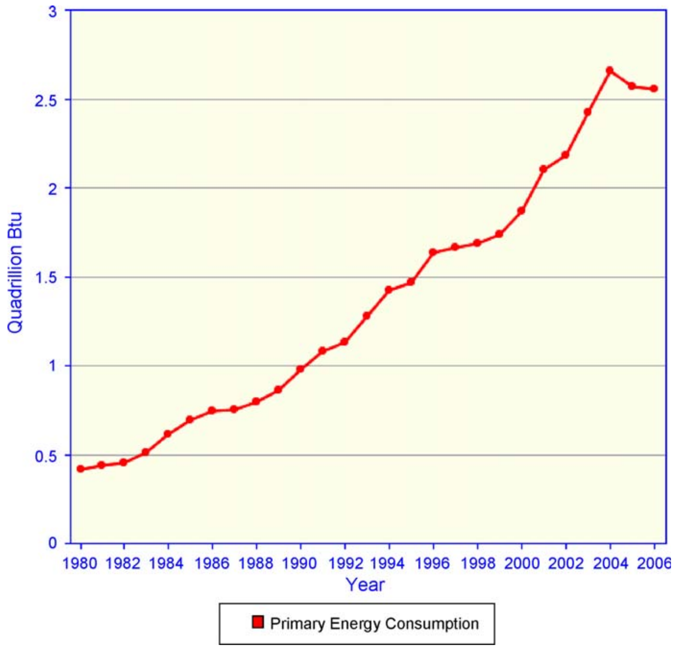


Fig. 3. Total primary energy consumption in Malaysia [8].

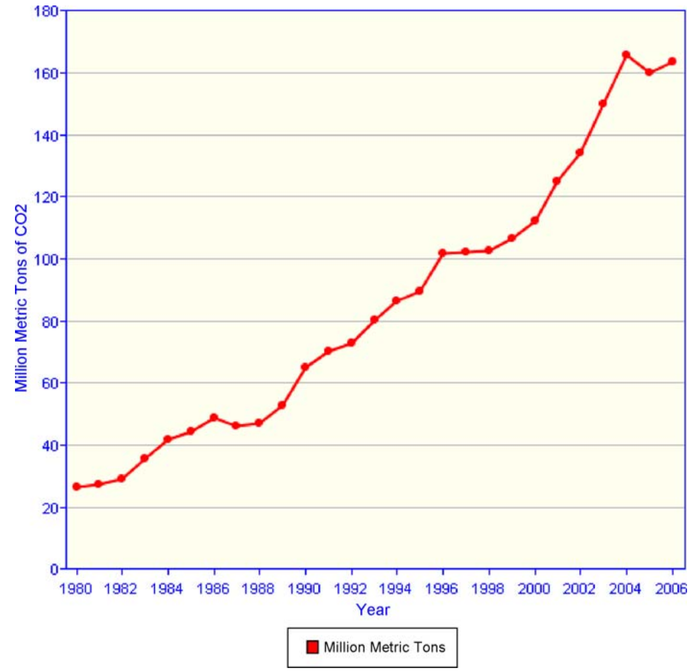


Fig. 5. Total CO_2 emission in Malaysia [8].

It is evident that Malaysia is still very much dependent on fossil fuels, mainly natural gas, coal and oil, in its commercial energy demand and electricity generation. With the escalating energy demand in sustaining the country's growth in years to come, it is inevitable that CO_2 emission will continue to climb, as long as fossil fuels remain as the main contributor in the energy mix. Fig. 4 summarizes the CO_2 emission in Malaysia by sectors in 2005. The transportation sector which fully utilizes petroleum products is no doubt the main contributor in CO_2 emission, followed closely by the electricity sector which is mostly powered by fossil fuels like natural gas and coal. The total CO_2 emission in Malaysia has increased quite drastically towards the end of 1990s and exceeded 160 million metric tonnes (MMt) by 2003, and has stayed above that level since, as illustrated in Fig. 5. With future energy demand expected to grow at a rate of 5–7.9% annually for the next 20 years from 2004 onwards [11], energy security is becoming a serious issue as fossil fuels are non-renewable energy and will deplete eventually.

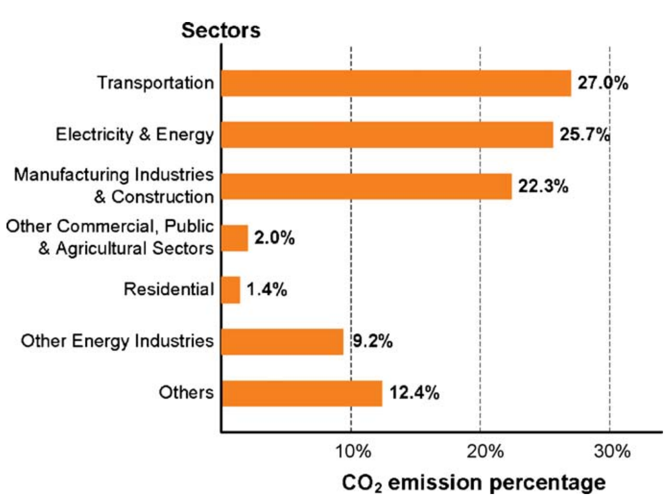


Fig. 4. CO_2 emissions by sectors in Malaysia [10].

2.2. Energy policy

At present, most of the developed countries are committed to cap their CO_2 emissions as stipulated under Kyoto Protocol as well as the recent declaration during the recent 2009 Climate Summit. In this respect, developing countries are still lacking behind most of the developed countries, but are catching up quickly. Malaysia as one of the fastest growing countries in Southeast Asia is continuously combating global warming with aggressive efforts. Over the years, the government has devised quite a number of energy-related policies to ensure sustainability and security in its energy supply for long term. Therefore, in the last three decades, pragmatic energy policies have facilitated a more environment-friendly energy development path, started with the introduction of the National Energy Policy in 1979 with three primary objectives; supply, utilization and environmental. The National Depletion Policy was announced in 1980 and a year later, the Four-Fuel Diversification Strategy 1981 was introduced, with the former to prolong lifespan of the country's oil reserves for future security and stability of oil supply, and the latter to pursue balanced utilization of oil, gas, hydro and coal. The fuel diversification policy is reviewed from time to time to ensure that the country is not over-dependent on one main energy source, especially after the international oil crisis in the 1970s. This policy was replaced in 1999 by the five-fuel diversification strategy with renewable energy (RE) became the fifth fuel in the energy supply mix. The direct result from the fuel diversification strategy saw the drastic drop of oil in the energy mix contribution, from a high 87.9% in 1980 down to a mere 2.2% in 2005, with the remaining 70.2% and 21.8% coming from natural gas and coal respectively [12]. Nevertheless, as fossil fuels still form a large share in Malaysia energy consumption, not only will these non-renewable energies be totally exhausted one day and cause energy security threat, their significant and prolong contribution to the emission of GHGs from their combustions is hastening the global warming as well. Thus, in addition to the five-fuel policy, the government has endorsed the Kyoto Protocol in September 2002 and being a non-Annex 1 country, Malaysia can utilize the CDM to reduce

domestic CO_2 emissions as well as transfer advanced technologies from developed countries.

The five-fuel policy has targeted to contribute 5% of the country energy mix with RE by year 2005 and mitigate 70 million tonnes of CO_2 over a span of 20 years [13]. Parallel to this goal is the Small Renewable Energy Programme (SREP) which was launched in May 2001 under the initiative of the Special Committee on Renewable Energy (SCORE) to support the government's strategy to intensify the development and utilization of RE as the fifth fuel resource in power generation, which is also stipulated in the objectives of the Third Outline Perspective Plan (OPP) for 2001–2010 and the 8th Malaysia Plan (2001–2005) (8MP). The primary focus of SREP is to facilitate the expeditious implementation of grid-connected RE resource-based small power plants [14]. The RE resources in this program include biomass, solar, mini-hydro and municipal solid waste (MSW), with the first two identified as having the most potential to perform. The biomass resources in Malaysia are mainly from palm oil residues, wood residues and rice husks that can be used in the heat and electricity generation [11]. Table 1 summarizes the RE potential estimation in Malaysia by the Malaysia Energy Commission. By August 2005, SCORE reported that a total of 63 projects were approved with biomass and mini-hydro accounted for 92% of the total projects and the remaining 8% from MSW. There was no project approved under solar and wind. The statistics on these projects are tabulated in Table 2.

Although the SREP has targeted to generate 5% or 600 MW of the country's electricity from RE by 2005, only 0.3% was achieved. Obviously, the progress in bringing RE generation into the mainstream has been slow due to several reasons and limitations. For any green technology industry to succeed, the right support mechanisms must be in place to create the market. The main obstacles to RE development in Malaysia are the lack of a policy framework and a financial mechanism. Without a legal and financial framework, the promotion of RE usage is often difficult. Moreover, the prohibitive price of RE gives households and businesses little incentive to adopt the technology, on top of the limited loans allocated for RE development. Beyond this, a lack of consulting services and access to the information on RE are also hampering its development [11]. Another key stumbling block is the high capital cost of RE implementation and the low sales price of electricity (17 cents/kWh) make the production of RE considered as uneconomical [18].

Nevertheless, the green technology promotion was further emphasized in the 9th Malaysia Plan (2006–2010) (9MP) where efforts in the utilization of RE resources and efficient use of energy are further encouraged. The establishment of the Ministry of Energy, Green Technology and Water to replace the Ministry of Energy, Communications and Multimedia in early 2009 reflects Malaysia's seriousness in driving the message that 'clean and green' is the way forward towards creating an economy that is based on sustainable solutions. The launch of the new National Green Technology Policy in April 2009 by the current Prime Minister, Datuk Seri Najib Tun Razak, shall provide guidance and create new opportunities for businesses and industries to impact on the economic growth positively. The National Green Technology Policy is built on four pillars – (1) seek to attain energy independence and promote efficient utilization; (2) conserve and minimize the impact on the environment; (3) enhance the national economic development through the use of technology; and (4) improve the quality of life for all. It will also form the basis for all Malaysians to enjoy an improved quality of life, in line with the national policies, including the National Outline Perspective Plan where the growth objectives for the nation will continue to be balanced with environmental consideration [19]. While fossil fuels is expected to remain the dominant source of energy for decades to come, energy from RE such as wind, solar, biomass, biofuel and geothermal heat is expected to double between now to year 2030, although their share in the energy mix is most likely still be around 5.9% of the total energy demand by 2030 [20].

Table 1
Renewable energy potential in Malaysia [15].

Renewable energy	Potential (MW)
Hydropower	22,000
Mini-hydro	500
Biomass/biogas (oil palm mill waste)	1300
Municipal solid waste	400
Solar PV	6500
Wind	Low wind speed

3. Energy efficiency (EE)

There is in general a stronger focus on energy supply than on energy use. One reason for this is that secure, reliable and competitive energy supply is crucial for the industry which has a major influence on the prevailing energy policies in any countries. Another reason is that energy users are less well organised than energy suppliers. Thus, the role of governments and their energy policies are becoming more and more important [21]. As a result, besides promulgating the use of RE to ensure energy security and sustainability for continuous economic growth, EE is explicitly addressed in the 9MP by the government. EE programs are more focused on energy saving features in the industrial and commercial sectors as well as domestic residential sectors. The industrial sector is expected to implement measures for improvements in plants, equipment and processes as well as end uses. Efficient Management of Electrical Energy Regulations are to be introduced, Uniform Building By-Laws to be amended to incorporate EE features, and specifications promulgated for accurate and informative electrical appliance labelling to be further enhanced. Promotion of the use of high efficiency motors includes initiatives to develop local expertise in the manufacture of energy-efficient equipment and machinery. EE measures are to be intensified in the

Table 2
Status of SREP projects approved by SCORE as in 2005 [16,17].

Type	Energy resource	Approved application	Generation capacity (MW)	Grid-connected capacity (MW)
Biomass	Empty fruit bunches	25	220.5	174.8
	Wood residues	1	6.6	6.6
	Rice husk	2	12.0	12.0
	Municipal solid waste	1	5.0	5.0
	Mix fuels	3	19.2	19.2
Landfill gas		5	10.2	10.0
Mini-hydro		26	101.9	97.4
Wind and solar		–	–	–
Total		63	375.4	325.0

Table 3
Emission reduction impact of MIEEIP energy audits [22].

Sectors	Food	Wood	Ceramic	Cement	Glass	Rubber	Pulp and paper	Iron and steel	Total
Energy consumption ('000 GJ/year)	1835	1032	774	21,557	4000	611	5080	4223	39,113
Energy costs (10^6 RM/year)	42.2	13.5	24.1	204.2	97.8	16.9	84.2	160.1	643.0
No cost	24	8	39	1	31	57	52	64	277
Low cost	111	132	75	7	14	21	69	57	486
High cost	238	221	42	337	59	84	691	149	1821
Total savings ('000 GJ/yr)	374	361	155	345	104	162	812	270	2583
Total cost savings (10^6 RM/year)	8.5	5.2	6.0	33.8	2.5	4.3	19.8	5.3	85.3
CO_2 emission reductions (kt/year)	28.0	30.4	14.5	444.7	8.1	18.9	194.4	22.8	761.7
# of audited factories	10	7	6	3	3	9	6	4	48
Factories registered	471	75	54	54	18	134	134	148	1,088

industrial, transport and commercial sectors, and in government buildings [15].

The industrial sector is the largest consumer of energy. Over the 8MP, the energy consumption was projected to grow at an average of 7.8% annually and more than double over a 10-year period if no initiatives are implemented to improve the EE performance in the sector. The manufacturing sector consumed 38.2% of the total commercial energy at the end of 2005, an increase from 37.1% from 2000 (at the end of the 7MP). In keeping the plan targeting the Malaysian industrial energy consumers, the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) was jointly initiated in late 2000 by the government, Global Environment Facility (GEF) and United Nation Development Program (UNDP), with the mandate to reduce the barriers to industrial EE and conservation, besides building institutional capacities in relevant organizations for sustainability.

In addition to the burning of fossil fuels, major industry sources of GHG emissions are cement, steel, textile, and fertilizer manufacturers. The main gases emitted by these industries are methane, nitrous oxide and hydroflurocarbons, which increase the atmosphere's ability to trap infrared energy. Energy audit activities carried out in eight energy intensive industrial sectors (wood, food, glass, cement, rubber, pulp and papers, iron and steel, ceramic) revealed potential energy savings amounting to 7.1 million gigajoules (GJ) per year with an estimated capital expenditure of RM100.4 million (US$ 28.7 million). At the same time, Malaysia's Energy Efficiency Plan (EEP) envisages a potential energy saving of over 1400 GWh over the equipment lifetime, equivalent to RM238 million (US$ 68 million) for an investment of RM33 million (US$ 9.4 million) by the government in program expenses over the remaining period of 8MP, and extended up to 2006. Among the achievements of MIEEIP as in January 2008 are available in [22]. Table 3 below summarizes the reductions in terms of energy consumptions, costs and CO_2 emissions achieved by MIEEIP in all the eight sectors from a total of 48 audited industrial companies up to 2007.

A more recent EE effort in Malaysia that is worth mentioning is the Green Building Index (GBI) launched in May 2009 by the Malaysia Architect Association and the Association of Consulting Engineers Malaysia (ACEM) to assess the impact of a new building on the environment based on the six criteria of EE – indoor environment quality, sustainable site and management, materials and resources, water efficiency, and innovation. The index is soon becoming a standard for all buildings in Malaysia because it recognizes and rewards advances in EE through better technology and smart design [14]. Commercial and residential buildings alone account for 13% and 48% of total energy and electricity consumption in Malaysia respectively, indicating that the country has a strong need and great potential to apply EE strategies in lowering energy consumption in buildings [23]. Thus, the government is embarking on energy conservation in the building sector, starting with the government offices. The low energy office (LEO) building completed in 2004 which currently houses the Ministry of Energy, Green Technology and Water has set the benchmark for more buildings to be built in the country with EE and RE features integrated in the building design [24]. The LEO building was targeted to achieve a building energy index (BEI) of 100 kWh/m^2 per year and energy savings of more than 50% compare to buildings without EE design. Table 4 shows the basic comparison analysis of the LEO versus a conventional building [13].

Taking full advantage of the solar potential, in 2005, the 5-year Malaysian Building Integrated Photovoltaic Technology Application Project (MBIPV) was launched. This project is jointly funded by the government, Global Environment Facility (GEF), and private sector with the intention to encourage the long-term cost reduction of non-emitting GHG technologies by the integration of energy generating photovoltaic (PV) technology in building designs and envelopes. Over the lifetime of the project, the energy generated is expected to be able to avoid 65,100 tonnes of CO_2 emissions from the country's power sector [25]. The project has several demonstration PV projects in residential houses and commercial buildings. The most considerable recent project is the green energy office (GEO) building, an administration-cum-research office for Malaysia Energy Centre, constructed following the success of the LEO. The GEO building is a pilot project and demonstrator building which marked another milestone towards greater promotion and adoption of sustainable building concept. The building PV panels are integrated into the building design to

Table 4
Basic economic comparison analysis between the LEO and a conventional building [13].

Description	Energy cost (RM/year)		
	Cooling energy	Electrical energy	Total
(A) Conventional building BEI = 275 kWh/m^2	478,000	620,000	1099,000
(B) LEO building BEI = 114 kWh/m^2	156,000	338,000	493,000
Savings (A) – (B)	322,000	282,000	604,000
Percentage savings (%)	67.4	45.5	55.1

LEO building base cost = RM50 mil (air conditioned area = 19,200 m^2). Additional cost for installation of EE features in LEO building – RM5.048 mil (10% of base cost). Annual energy saving = RM0.604 mil/year. Payback period = 8.4 years.

provide electricity for the building uses and are connected to the national electricity distribution grid by feeding electricity into the network and shaving the peak power demand of the grid during the peak daylight hours. The system provides almost 50% of daily electrical needs. In daytime, the system will feed any surplus of energy back to the distribution grid. At night, the electrical energy was imported back from the grid to be used for the cooling system. At the moment, the GEO building has achieved BEI of 65 kWh/m^2 per year without PV generation and this can further reduce to 35 kWh/m^2 per year with it. As more and more government buildings with EE and RE features to be constructed in the future, it is hoped that the private sector will be encouraged to follow suit and practice EE as a way of life. Other green technology features of the building can be found in [26].

In the recent Malaysia Budget 2010 announcement, the GBI is given a further boost as incentives will now be given to owners/buyers of buildings with GBI certificates. An owner of a building who incurs capital expenditure to obtain a GBI certificate will be granted an allowance equivalent to 100% of the capital expenditure incurred which may be offset against 100% of its statutory income. Buyers of buildings and residential properties which have GBI certificates will be entitled to stamp duty exemptions in respect of the additional costs incurred to obtain the GBI certificate. It is unclear at this stage as to how the mechanism of this exemption will operate, but this will presumably require the developers to indicate the additional costs incurred to obtain the GBI certificates. These incentives will apply in relation to costs incurred per building purchased between 24 October 2009 and 31 December 2014 [27].

4. Carbon trading and its challenges

To have a better understanding on how carbon trading started from the Kyoto Protocol, a brief explanation on the mechanism is presented.

4.1. How does carbon trading work?

The concept of carbon credits come into existence as a result of increasing awareness on the need for pollution control. It was formalized in the Kyoto Protocol, an international agreement between 169 countries under the United Nations Framework Convention on Climate Change (UNFCCC). The protocol sets quantified and binding targets for the developed (Annex I) countries to reduce emission of GHGs by an average of 5.2% of the 1990 level over a 5-year commitment period from 2008 to 2012. To meet their commitments under the protocol, these countries must give priority to the implementation of regional or national policies and measures. Three market-based mechanisms of the Kyoto Protocol are set up to help meet their targets in a cost effective and green manner; (1) International emission trading (IET) – the carbon credit market, (2) Clean development mechanism (CDM), and (3) Joint implementation (JI). Under JI, a developed country with relatively high costs of domestic greenhouse reduction would set up a project in another developed country that has a relatively low cost. A developed country can take up a GHG reduction project activity in a developing country through CDM where the cost of such activities is usually much lower. The developed country would be given credits for meeting its emission reduction targets, while the developing country would receive the capital and clean technology transfer to implement the project. Countries can then trade in the international carbon credit market through the IET mechanism. Countries with surplus credits can sell them to countries with quantified emission limitation and reduction commitments under the Kyoto Protocol [29,30].

Of these three mechanisms, CDM is the only mechanism that involves non-Annex I countries aims at promoting co-operative measures between the industrialized (Annex I) and the developing (non-Annex I) countries. As a non-Annex I country, the CDM is thus the only mechanism under the protocol that is relevant to Malaysia. The CDM is proposed with the twin objectives of helping Annex I countries to achieve their emission reduction targets and at the same time helping non-Annex I countries to promote sustainable development in their economies. The CDM idea is to facilitate co-operative projects between developed and developing countries to reduce GHG emissions, with the opportunity for additional financial and technological investments in GHG reduction projects. The GHG reductions achieved by each CDM project will be quantified in standard units, to be known as Certified Emission Reductions (CERs); a form of carbon credits. It involves the trading of emission reductions resulted from a specific project (called CERs once such reductions are certified) to countries that can use these CERs to meet their targets. In return for the CERs, there will be a transfer of money to the project that actually reduces the GHGs [31].

Obviously, carbon credits are a tradable permit scheme, creating a market for reducing GHG emissions by giving a monetary value to the cost of polluting the air. A credit gives the owner the right to emit one tonne of CO_2. International treaties such as the Kyoto Protocol set quotas on the amount of GHGs countries can produce. These countries, in turn, set quotas on the emissions of businesses. Businesses that are over their quotas must buy carbon credits for their excess emissions, while businesses that are below their quotas can sell their remaining credits. By allowing credits to be bought and sold, a business for which reducing its emissions would be expensive or prohibitive can pay another business to make the reduction for it. This minimizes the quota's impact on the business, while still reaching the quota. Credits can be exchanged between businesses or bought and sold in international markets at the prevailing market price [29]. In effect, the buyer is being charged for polluting, while the seller is being rewarded for producing less contaminant. Presently, carbon trading is most developed in the European Union (EU), where the EU trading system that has been in effect since 2005, accounted for US$ 24 billion (about 80% of total trades) in 2006. There are currently two exchanges for carbon credits; the Chicago Climate Exchange and the European Climate Exchange. The World Bank has estimated the global carbon credit market to be worth US$ 30 billion in 2006, up 3-fold from 2005 [31].

4.2. Potential in Malaysia

As GHG emission levels are predicted to keep rising over time, it is envisioned that the number of companies wanting or needing to buy more credits will increase, thus pushing the market price up and encourage more groups to undertake environmentally friendly activities that will create for them carbon credits to sell. Another model as mentioned before is that, companies that use below their quota can sell their excess as carbon credits. The possibilities are endless hence making it an open market [29].

Despite carbon trading being relatively new in Malaysia, a biomass project in Sabah, a state in east Malaysia, is actually the first in the world to be awarded CERs by the United Nation Executive Board of CDM. In fact, corporate sectors in the country such as power manufacturing, waste management, forestry, oil and gas manufacturing, agriculture and transportation sectors which are identified as potential beneficiaries, have been proactive to capitalize on CDM participation. As in March 2009, based on data released by the United Nations Environment Programme (UNEP) resource centre, there are a total of 4660 future CDM projects registered, with Malaysia having 156 projects or 4% of the list in the pipeline, as charted in Fig. 6. Asian countries are generally making headway in carbon trading, with China and India leading the pack

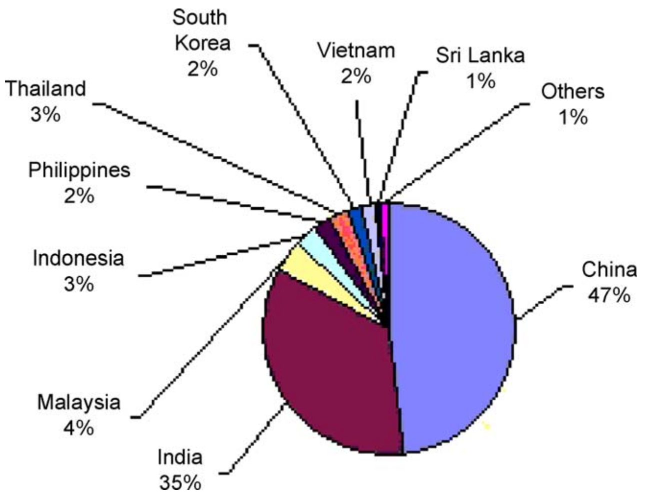


Fig. 6. Rough estimation of CDM projects in Asia by country by UNEP as of March 2009 [28].

at 55.24% and 12.78% respectively, based on the reported average annual CERs from registered projects as in 2008 (see Fig. 7). Malaysia already has 22 registered CDM projects with most the CERs coming from biomass plants. As of March 2007, two of the 22 CDM projects had sold 320,000 tonnes of CERs valued at less than RM10 million (US$ 2.86 million) [32]. According to the Malaysia Energy Centre (MEC), agricultural and natural resources-rich Malaysia has 100 million tonnes of carbon credit, which is translated to RM4.8 billion (US$ 1.37 billion) in revenue and could potentially benefit from carbon trading, which is now worth US$ 60 billion globally. UNFCCC estimates carbon trading has the potential to grow to US$ 1 trillion in the next 10-years. As the emission trading scheme under the Kyoto Protocol commences in 2008 and couples with financial contribution to projects by CDM in reducing GHG emissions, various domestic sectors are poised to benefit from carbon trading [33].

For a project to qualify as a CDM project, it should be able to demonstrate that the revenues from CDM can help to overcome some existing financial or other barriers which are not possible without the financial assistance. Thereafter, several transaction costs have to be made, ranging from US$ 40,000 to US$ 150,000, to register a project as a CDM project before tradable CERs can be generated. Projects in the pipeline can be grouped in the following categories; agriculture (composting), EE, landfill gas to electricity, landfill gas flaring reduction, manufacturing industry, RE (biomass, biogas and hydropower) and animal waste. Table 5 provides an overview of the expected potential from CER revenues for different

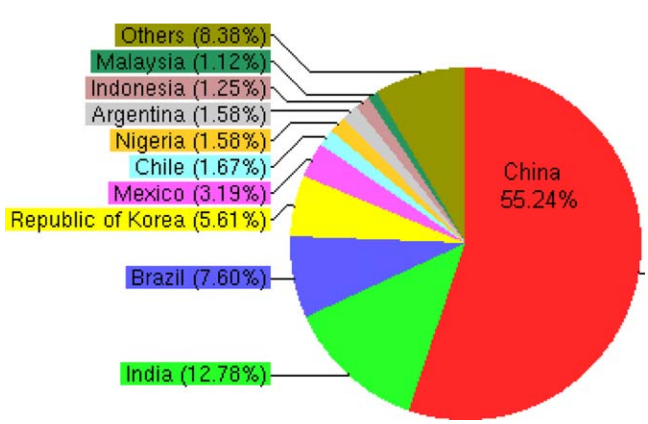


Fig. 7. Average annual CERs from registered projects by country 2008 [28].

Table 5
Estimated CDM revenues from various projects in Malaysia [30].

Project type	Estimated CERs in 2010 (RM'000)	Potential electricity (MW)
Biogas POME[a] and animal manure	5900	190
Landfill gas	3700	45
Reduction of gas flaring from oil production	4600	N/A
Mini-hydro	70	25
Biomass CHP[b]	380	90
Others	3150	N/A
Total	17,800	350

[a] Palm oil mill effluent.
[b] Combined heat and power.

types of projects in Malaysia and the corresponding amount of energy in megawatt (MW) that can be installed from RE by 2010. The results are preliminary and only based on an assessment of the potential in the energy sector. The realization of this potential will depend upon the removal of other existing barriers for these project types [30].

As a developing country with ample of agricultural and natural resources, the most obvious beneficiary CER trading in Malaysia is no doubt in the plantation sector, with oil millers in particular. When the carbon trading legislation is imposed in the western countries. Malaysia is one of the top palm oil producers in the world, second only to Indonesia. With an annual crude palm oil production of 17.7 million tonnes in 2008 and the 395 operating oil mills, Malaysia has the potential to rake in RM252 million (US$ 72 million) of yearly income from three typical projects; composting of empty fruit bunches (EFB) and palm oil mill effluents (POME), biogas recovery from effluent to energy, and conversion of biomass (palm kernel shells, EFB) to energy. Apart from the country's abundant biomass waste resources from oil palm, wood residues and agro-industries such as rice husk also have huge potential to be utilized as biofuel, either for stationary or transport applications. As a type of RE, apart from their role in GHG emission reduction, biomass and biofuel actually provide security of energy supply and sustainability.

4.3. Challenges and the way forward

The cutback on GHGs emissions can be accomplished by restructuring company operations and processes to physically reduce emissions and through purchases of carbon credits to meet the carbon emission reduction deficits. The reduction can be achieved through financial exchanges by supporting the CDM or simply by buying carbon credits from companies or developed countries that have excess allowances. Carbon credits are awarded to projects in a country by the Designated Operational Entity (DOE) after grilling through the stringent and complex procedures adopted by the UNFCCC to be certified as having reducing a real and quantifiable amount of GHGs [34]. Since CERs can be traded and used by developed countries to comply with emission reduction targets, hence this shall create a win–win situation between developing and developed nations.

The objective of the Kyoto Protocol is noble, but the complex trading system has been open to abuses. Problems emerge due to serious flaws in the checking system on actual achievement in GHG reductions. Under the protocol, a CDM project needs to demonstrate that it will lead to a quantifiable reduction in GHGs and that it would not have been economically viable without the additional capital generated by carbon trading. It is estimated that up to 20% of the carbon credits issued did not match genuine reductions, thus risks creating a false sense of security in the system. Some parties

have argued that the CDM process has been manipulated, particularly by the owners of large-scale hydropower plants, which remain environmentally controversial. Besides questioning the effectiveness of carbon markets, carbon credits have been disputed as a way for an organization to throw money at a problem instead of taking action to reduce their own carbon footprint of their operations. To drive large-scale investments and financial flows to developing countries for significant global emissions reduction, investment barriers need to be resolved, present CDM need to be extended and streamlined or new mechanisms established, regional and national carbon markets need to be linked internationally [28].

Malaysia government has been very supportive and instrumental in the CDM participation and has established the machinery and mechanisms for smooth implementation to tackle the GHGs emissions and the promotion of carbon trading in the country. To encourage corporations to go green, the Malaysian government has exempted carbon credit income from tax from 2008 to 2010. From a corporation's perspective, the main incentive to go green would be that such practices make good corporate social responsibility as well as its cost recovery potential [33]. In the announcement of the country's Budget 2008, an additional 10-year pioneer status were granted to companies involved in energy conservation, on top of a 3-year tax exemption for income derived from carbon credits trading. In the more recent Budget 2010 measures outlined by the Prime Minister, Datuk Seri Najib Tun Razak, among other green technology developments to be initiated by the government are [35]:

- Restructure the MEC to National Green Technology Centre with the task to formulate a green technology development action plan. This centre will function as the focal point to set standards and promote green technology. To intensify green awareness activities and practice environment-friendly lifestyle, an allocation of RM20 million will be provided.
- An international exhibition on green technology to be organised in April 2010. The exhibition is expected to attract internationally renowned companies and experts in green technology.
- Develop Putrajaya and Cyberjaya as pioneer townships in green technology, as a showcase for the development of other townships.
- Priorities are to be given to environment-friendly products and services that comply with green technology standards in government procurement.

A fund amounting to RM1.5 billion (US$ 430 million) will be allocated to provide soft loans to companies that supply and utilize green technology, with maximum financing up RM50 million (US$ 14.3 million) for suppliers and RM10 million (US$ 2.9 million) for consumer companies, while the government shoulders 2% of the total interest rate. On top of that, the government is providing a guarantee of 60% on the financing amount, with the remaining 40% by banking institutions. Loan applications are made through the National Green Technology Centre and this scheme which had commenced since 1st January 2010 is expected to benefit 140 companies [33]. Although the funding amount is pale in comparison to many similar commitments in other countries, it is considered a first major step taken by the government to show its seriousness in addressing global warming and moving towards a low carbon economy.

The recently concluded 2009 Climate Change Conference offered the best hope for a global framework of co-operation on climate issues, whereby under this convention are the fair principles of equity and historical responsibilities due to the need of Annex I parties to repay their climate debts. In the summit, Malaysia has taken its stand and made a voluntary pledge to adopt a national reduction indicator of 40% in terms of its 2005 GDP emission intensity levels by 2020 as its contribution towards global efforts to combat climate change. The voluntary indicator will serve as a measure to the country's progress in climate action. However, the indicator is conditional upon the transfer of technology and adequate financing from Annex I partners. In order to realize the 40% target, it will very much depend on a coherent national plan and a specific climate-related legislation which the country is currently lacked of. However, the launch of the National Green Technology Policy in April 2009 with its five objectives which include decreasing energy consumption while enhancing economic development, facilitating the growth of green technology industry and enhancing its contribution to the national economy, did give a new breath of fresh air in the national policy scene as it is set to play an important role in charting the country's development with green technology as the new driver for economic growth. A Green Technology Council which is chaired by the Prime Minister himself will also be established to facilitate the role of stakeholders to ensure the successful implementation of the green technology roadmap.

Not to be taken lightly the impact from the private sector, the government is planning incentives for the private sector that adopts green technology in their business. As going green is about new technology, a different type of employee is necessary to work in a green economy and technology-based companies should also look into researching new and more efficient RE. Currently, there is still a lack of awareness among Malaysians on what going green really means and only large corporations with huge carbon emissions will embrace such practices. Smaller companies with significantly less carbon emission will find it time consuming and not cost effective to invest in such schemes because of the stringent guidelines and criteria set under the Kyoto Protocol. But companies that adopt green and sustainability practices normally tend to progress much faster and are perceived as good employment choices. Therefore, all corporations should not detract from their sustainable practices just because it incurs additional cost to do so. Qualitatively, engaging in sustainable, environmentally sound strategies and practices also make for good corporate responsibility and contribute to a cleaner environment. In fact, by not observing sustainable practice, a company might actually run the risk of going out of business as the looming fossil fuel-led industrial era will eventually replace by the low carbon era. This calls for a policy where the development of RE technologies goes hand in hand with a more efficient use of the primary energy in order to reduce dependence on traditional energy sources. In this respect, it is important that decision makers are updated on the actual development, status and potential of RE technologies in order to provide relevant incentives. Furthermore, it is important that these incentives are introduced in relation to stronger and more far-sighted measures to ensure a more efficient use of primary energy.

5. Conclusion

There are major things every country can do on the basis of existing knowledge on RE, EE and deforestation in order to make a big difference over decades to come. Then a long-term framework of incentives is required to succeed the Kyoto Protocol and to develop the technologies for a sustainable future. The seriousness of Asia powerhouses such as China and India, and other emerging markets with similar enthusiasm to participate in tackling climate change issue offers a huge opportunity that should be grasped and take note of. The fact that oil has once reached close to US$ 150 a barrel not so long ago had set an example on the fragility of energy security and why

every nation needs to change the nature of their economies to drive down carbon dependencies.

In the light of concerns about global warming due to human enhancement of the greenhouse effect, there is clearly a growing concern about how energy needs are addressed on a sustainable basis. Considering also the high fossil fuel prices and the fact that Malaysia is richly endowed with RE sources, these sources have become a more attractive option for energy and electricity generation. Despite a long-term effort in Malaysia, RE sources, EE and carbon trading are not yet utilized to anywhere near their full potentials. With the Kyoto Protocol commitment between 2008 and 2012, Malaysia is nevertheless well positioned to benefit from the CDM projects. However, there is a need to build capacity in the country to adapt policies and regulations, harmonize policy instruments and achieve local terms to promote these concepts [36].

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